Surveillance for Moderate-Sized Thoracic Aortic Aneurysms: Equality is the Goal

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Comprehensive clinical and imaging-based surveillance represents a fundamental aspect in the management of thoracic aortic aneurysms (TAAs), affording the opportunity to identify intermediate-sized TAAs before the onset of worrying symptoms or devastating acute aortic dissection/rupture. Currently, size-based indices are favoured as the major determinants driving patient selection for surgery, as supported by aortic guidelines, although it is recognised that smaller sub-threshold TAAs may still confer substantial risks. Prophylactic aortic surgery can be offered within set timeframes at dedicated aortic centres with excellent outcomes, to mitigate the threat of acute aortic complications associated with repeatedly deferred intervention. In this commentary, we discuss a recent article from the Journal of Cardiac Surgery which highlights important socio-economic disparities in TAA surveillance and follow-up.

Surveillance for Moderate-Sized Thoracic Aortic Aneurysms: Equality is the Goal

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Abstract

Comprehensive clinical and imaging-based surveillance represents a fundamental aspect in the management of thoracic aortic aneurysms (TAAs), affording the opportunity to identify intermediate-sized TAAs before the onset of worrying symptoms or devastating acute aortic dissection/rupture. Currently, size-based indices are favoured as the major determinants driving patient selection for surgery, as supported by aortic guidelines, although it is recognised that smaller sub-threshold TAAs may still confer substantial risks. Prophylactic aortic surgery can be offered within set timeframes at dedicated aortic centres with excellent outcomes, to mitigate the threat of acute aortic complications associated with repeatedly deferred intervention. In this commentary, we discuss a recent article from the *Journal of Cardiac Surgery* which highlights important socio-economic disparities in TAA surveillance and follow-up.

Keywords: thoracic aortic aneurysm; surveillance; acute dissection; socioeconomic

Surveillance is of paramount importance in the management of thoracic aortic aneurysms (TAAs). Aortic guidelines clearly define the surgical indications for operating on larger TAAs exceeding a diameter of 5.5 cm[1-3], since the attributed dissection/rupture risks are deemed to outweigh the predicted operative risks. However, the optimal timing of aortic replacement in those with smaller TAAs not fulfilling these surgical criteria is less well established[4]. Such patients are traditionally enrolled in an active surveillance programme, comprised of regular outpatient clinic assessment and evaluation of aortic dimensions with serial cross-sectional imaging with computed tomography (CT), or magnetic resonance imaging (MRI) in younger individuals, combined with echocardiographic follow-up. Annual and six-monthly CT/MRI is recommended for aneurysms measuring 3.5-4.4 cm, and 4.4-5.4 cm, respectively[1,2].

In this issue of the Journal, Shang and colleagues draw our attention to troubling variations in the surveillance and follow-up of patients with lower socio-economic status[5]. In their retrospective review, 465 patients diagnosed with an ascending TAA [?]4 cm in diameter between 2013-2016 were stratified into quartiles according to the area deprivation index as an indicator of socio-economic status, with the primary outcome of interest being clinical follow-up with a cardiovascular specialist and aortic surveillance imaging within two years from an index scan. Interquartile differences in risk of death preceding cardiovascular specialist follow-up were also determined utilising competing risks analysis.

The authors discerned that patients in the top three quartiles, corresponding to higher socio-economic status, were significantly more likely to have been under pre-existing or new follow-up with a cardiologist ($p<0.001$) or cardiac surgeon ($p=0.002$) for their ascending TAA, than their counterparts in the lowest quartile ($p<0.001$). Only 16% of patients in the lowest quartile without pre-established follow-up were newly reviewed by a cardiologist during the study period ($p<0.001$). Although there were no significant interquartile differences between the top and lowest quartile in ascending TAA size at the time of surgery, 92% of patients in the lowest quartile displayed symptoms at the time of surgery, compared to just 25% in the top quartile. Less disadvantaged quartiles were more likely to undergo imaging within 2 years compared to the most disadvantaged quartile (Q2 88% vs. Q4 71%, $p<0.001$), even when adjusting for factors, including family history of TAA, active malignancy, smoking history, congestive heart failure and COPD, which should ordinarily prompt further imaging. Compared to the upper quartile in which the competing event of death was reached in 11 patients in a median time of 1.91 (IQR 1.49-3.08) years, in the lowest quartile, the competing event of death was reached in 26 patients at a median time of 1.5 (IQR 0.95-2.29) years. On adjusted competed risks regression, patients in the lowest quartile were significantly less likely to have received follow-up prior to death (HR 0.46 [0.34-0.62], $p<0.001$) compared to those in the upper quartile.

Two major themes warrant further discussion here. The first is that of worrying disparities in the surveillance, follow-up and outcomes of patients from lower socio-economic backgrounds with TAAs. In this first reported study addressing surveillance outcomes in this population, Shang and colleagues[5] demonstrate that patients with lower socio-economic status were less likely to be under the clinical surveillance of a cardiovascular specialist, less likely to undergo imaging at an appropriate time interval, more likely to have poorer health at the time of surgery and more likely to have died before any follow-up. The authors do not provide further explanation to account for the significant discrepancies observed between those in the least- and most-disadvantaged groups. In the US, access to healthcare is dependent either on insurance coverage or self-funding by the patient. The management of TAAs and their complications is resource-intensive, and overall median cost for an index hospitalisation has been reported at US$16,683 for TAAs and US$11,525 for type A dissections between 2003-2016[6]. Those from more disadvantaged backgrounds with more limited financial resources or lack of health insurance may therefore be unable or unwilling to undergo referral to a cardiovascular specialist owing to the significant monetary implications. This may then preclude them from undergoing imaging evaluation, attending ongoing clinic appointments, receiving prescription medications for symptom and risk factor control, in addition to undergoing definitive surgical therapy and potential future reinterventions. Though perhaps beyond the scope of this paper, addressing these inequalities in healthcare

access and funding is certainly a complex, multi-faceted issue.

The second theme for discussion concerns moderate-size TAAs, their associated complication risks and selection for surgery. Alongside rupture, acute dissection remains the most devastating complication affecting proximal TAAs. With an incidence of approximately 10 per 100,000 patient-years[7], the vast majority of TAAs are clinically silent and may only declare themselves at the time of a potentially catastrophic adverse aortic event. Acute type A aortic dissection bears a 20% pre-admission mortality risk, increasing to 30% during the index hospital admission[8], with emergent open aortic repair representing the current gold standard management[9]. A large proportion of these dissections originate within significantly aneurysmal aortic segments, and insights gleaned from natural history studies indicate that the risk of dissection and rupture, as well as aneurysm growth rate, correlate closely with the absolute aortic diameter[10,11]. A landmark study published almost twenty years ago by Elefteriades' group in Yale depicted an annual dissection/rupture risk of around 2% in TAAs measuring 4.0-4.9 cm, rising to almost 7% in those exceeding 6 cm[12], a critical hinge-point beyond which diameter dissection would be anticipated in over 30% of patients[12,13]. An earlier study reported a dissection/rupture rate as high as 45.2% with TAA diameter >6 cm[14]. In the present study by Shang and colleagues, there was no significant difference in TAA sizes at surgery ($p<0.94$) with median diameter of 4.85-5.00 cm across all quartiles[5].

This valuable information provides the supporting evidence for the size-based surgical intervention for TAAs, as currently proposed in international guidelines[1-3]. Whilst surgical replacement of TAAs is generally undertaken at a diameter of 4.5-5.5 cm in both tri-leaflet and bicuspid aortic valve populations, it should be considered at 4.0-4.5 cm in those with a genetic predisposition to aortic disease, including those with inherited aortopathies such as Marfan and Ehler-Danlos syndromes, whilst accounting for additional risk factors, such as family history of dissection or rapid aneurysm expansion at >3mm/year[1,2]. Nevertheless, it is not uncommon for acute dissection to occur at aortic diameters smaller than these thresholds, fuelling the notion that prophylactic surgical intervention should be performed at more conservative aortic diameters. Indeed, dissection/rupture risk has been described in an important natural history study in 7.1% of patients at a diameter <4 cm, 8.5% at 4.0-4.9 cm, 12.8% at 5.0-5.9 cm, with 22% of patients overall experiencing dissection/rupture below the guideline cut-off of 5.5 cm[14]. Notably, an analysis of the International Registry of Acute Aortic Dissection (IRAD) database revealed that 59% of acute type A dissection occurred in patients with ascending aortic diameter <5.5 cm[15]. Our group's previous work examining the relationship between absolute aortic diameter and cross-sectional aortic area indexed to patient height demonstrated that significant proportions of TAAs possess smaller aortic diameters below the size cut-offs mandating surgical replacement, although their indexed aortic areas >10 cm^2/m signified their increased propensity for acute aortic dissection/rupture[16,17].

Many will share the viewpoint that TAA diameter in isolation does not accurately reflect dissection/rupture risk. However, until other uncomplicated, reproducible and validated indicators of aortic risk emerge, size-dependent criteria remain the major determinants that drive aortic replacement surgery worldwide, as endorsed by contemporary guidelines. Therefore, once even a relatively small TAA is identified, close clinical and imaging surveillance is warranted to determine the associated aortic risks and optimal timepoint for surgery. One should not become complacent when judging these smaller aneurysms. Ascending aortic dilatation to 4.0-4.4 cm represents an 89-fold increase in dissection risk, and dilatation to [?]4.5 cm confers a 348-fold risk[18].

In conclusion, this interesting article by Shang and colleagues[5], serves to highlight the importance of ensuring that patients with TAAs, whose smaller diameters do not satisfy surgical criteria, participate in a stringent surveillance programme with timely clinical, radiological and echocardiographic follow-up in adherence to established guidelines. Of equal importance, specialists involved in the management of aortic diseases should work to enhance access to the aortic services they provide to all corners of society, irrespective of their socioeconomic status. There is the chance here to afford a great deal of benefit for those who might otherwise not receive it. Proactive surveillance would identify patients harbouring dangerous TAAs at greatest risk of life-threatening complications, facilitate their selection for effective surgical repair and theoretically save

untold numbers from serious acute aortic events. To strive for excellence in care, means delivering excellent care for all.

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